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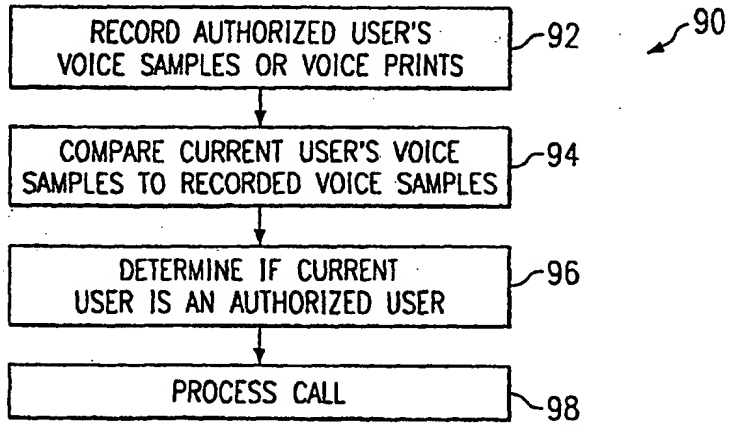
(54) Title: MOBILE STATION WITH VOICE RECOGNITION AUTHENTICATION

(57) Abstract

A wireless mobile station having voice recognition capabilities to determine authorized user of the mobile station. In the first embodiment, the mobile station is provided with a SIM card storing voiceprints of authorized users. A mobile station user provides voice samples which are compared against the voiceprints stored in the SIM card to determine a match before a call can be placed using the mobile station. In a second embodiment, voice samples of a current user are compared during a call in progress, and future calls are prevented until an authorized user is determined. An IN solution is also provided including voice recognition and authorization of mobile users placing calls or attempting to place calls over the wireless network.



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MOBILE STATION WITH VOICE RECOGNITION AUTHENTICATION

FIELD OF THE INVENTION

The present invention is generally related to communications networks including wireless telephony communication networks, and more particularly to wireless mobile stations including cellular telephones and the like.

BACKGROUND OF THE INVENTION

The infrastructure of wireless communication networks typically includes an originating network, a terminating network, and a communication link exchanging voice and data between these networks. The wireless communication network services multiple mobile stations via a radio frequency (RF) communication links. The wireless communication networks and mobile stations can be based on a variety of wireless standards including GSM, TDMA, CDMA, AMPS and D-AMPS.

Fraudulent use of mobile stations is a large problem faced by the wireless service providers and accounts for a significant portion of lost revenue. Costs associated with fraudulent use of the mobile stations is generally unrecoverable. To prevent the unauthorized use of mobile

stations, the communication network and/or the mobile stations can be provided with a variety of authentication mechanisms and protocols to insure that a mobile subscriber is an authorized user of a mobile station. In some schemes, authentication triplets are utilized whereby a mobile stations authenticates itself with the servicing network every time the mobile station enters service, i.e. at power up, or every time a mobile subscriber enters a new calling area. Coding techniques are also utilized to encrypt identification information of the mobile station including the mobile station's serial number and manufacturer number, which information is required to validate an authorized mobile station.

Other techniques to prevent unauthorized use of a mobile station include providing locking features of the mobile station itself. In this scheme, a code, such as a PIN number, is required to unlock the mobile station prior to use. This authorization scheme is effective as long as the mobile user consistently uses this feature, which is typically not the case of a typical mobile user. Thus, if the phone is left in the un-locked state, it can still be used by an unauthorized user.

There is desired an improved method to reduce or prevent fraudulent calls by a wireless mobile subscriber.

SUMMARY OF THE INVENTION

The present invention achieves technical advantages as a mobile station and wireless network having voice recognition features to ensure calls are made on the mobile station by only authorized users. Voice samples or voiceprints of a current mobile station user are compared to voiceprints of authorized users to verify authorized users of the particular mobile station. Several embodiments of the present invention are provided.

According to a first preferred embodiment of the present invention, voiceprints of authorized users are stored in a SIM card of the mobile station. Prior to making a call, a current user provides voice samples to the mobile station which are then compared with the voiceprints stored in the SIM card. If a match is found, the user is given an indication and allowed to proceed with the call. If a match is not found, the mobile station is disabled until a voice sample is provided and recognized. This authentication process can be required for each call, on a daily basis, or at power up, for example. The voice authentication process can be overridden with a personal identification number (PIN) number.

According to a second embodiment of the present invention, the mobile user places a call, and during the call the mobile station compares voice samples of the user with voiceprints stored in the SIM card to authorize the user. If a match is found, the mobile station remains active. If no match if found, however, the call is allowed to be completed, and at the end of the call the mobile station is disabled until a voice sample provided by a user is found to match with one of the stored voiceprints in the SIM card. This voice authentication process can also be overridden with a PIN number.

According to a third embodiment of the present invention an intelligent network (IN) solution is provided in the communication network infrastructure to provide voice recognition authorization of a mobile user attempting to use, or currently using, a mobile station served by the network.

The present invention provides voice recognition authorization in a public wireless environment. The mobile station handset can be controllably enabled or disabled depending on whether the voiceprints of the current user are found to match with stored voiceprints of authorized users for that particular mobile station. The present invention provides an

added security mechanism to reduce and/or prevent the unauthorized use of mobile stations, thus reducing the amount of lost revenues to wireless providers.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a communication network servicing mobile stations according to the present invention;

Figure 2 is a block diagram of a mobile station according to the present invention storing voiceprints of authorized users in a SIM card and provided with a voice recognition module;

Figure 3 is a block diagram of a mobile station according to an alternative preferred embodiment of the present invention having voiceprints stored on the SIM card, whereby speech is monitored by the mobile station during a call and compared with the stored voiceprints to authorize the mobile user;

Figure 4 is a block diagram of an IN solution to the present invention whereby an IN node of the network is provided with functional modules to perform voice recognition authorization of a mobile subscriber using the network;

Figure 5 is a block diagram of the functional modules comprising the IN node of Figure 4; and

Figure 6 is a flow diagram of the method of the present invention comparing voice samples of a user with recorded voiceprints of authorized users to authenticate a mobile user.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 illustrates a block diagram of a communication network 10 according to the preferred embodiment of the present invention. Communication network 10 preferably comprises a wireless telephony network seen to include an originating mobile station 12 coupled by an RF communication link to a servicing originating network 14. The originating mobile station 12 is preferably a wireless communication device comprising a wireless mobile station, but may also be a fixed wireless station. The mobile station 12 may operate based on any number of communication standards including AMPS, TDMA, D-AMPS, GSM, and IS-95 protocols. The originating network 14 is seen to be coupled to a transit network or communication link 16, which may comprise a public switched telephone network (PSTN), but could also comprise of other

networks including an optical network if desired. The transit network 16 interfaces and communicates electrical signals including digitized voice calls between originating network 14 and a terminating network 18. Terminating network 18 may be the same as, or different than, the originating network 14, and may comprise of AMPS, D-AMPS, TDMA, GSM and IS-95 networks. Terminating network 18 is coupled to and services via an RF link a terminating mobile station 20, which may comprise of a fixed or mobile station such as a wireless cellular or PCS subscriber. The wireless stations and networks may have codecs to provide encoding and decoding of digital signals communicated over the transit network 16.

The originating network 14 is seen to include a base transceiver station (BTS) 30 serving via a radio frequency (RF) link the originating mobile or fixed station 12. Each BTS 30 services multiple stations 12, although only one is shown for purposes of illustration and clarity. Originating network 14 is further seen to include a base switching center (BSC) 32 and a main switching center MSC 34. The BTS and BSC are sometimes collectively referred to as a base switching station (BSS). BSC 32 interfaces voice calls between multiple BTSs 30 and MSC 34, wherein

BSC 32 typically serves multiple BTSs 30, although only one is shown for purposes of illustrating the present invention. Similarly, MSC 34 services multiple BSCs 32, although only one is shown for purposes of illustrating the present invention. MSC 34 includes a visitor location register (VLR) which includes and stores various information of the stations 12 currently being served by the originating network 14.

Terminating network 18 is seen to include a BTS 40 serving the terminating station 20, and typically serves multiple stations 20. Terminating network 18 is further seen to include a BSC 42 and MSC 44. Terminating network 18 may operate according to the same operating protocol as originating network 14, i.e., both are GSM networks, or, the terminating network 18 may be different from the originating network 14, i.e., the originating network is GSM and the terminating network may be based on AMPS, D-AMPS, TDMA or IS-95 protocols. MSC 44 includes a VLR for maintaining a register of information for all stations 20 currently being served by the terminating network 18.

Transit network 16 is preferably a PSTN. Originating MSC 34 and terminating MSC 44 exchange digitized voice data thereover, which are preferably encoded in pulse code modulation (PCM) format, and

transmitted at about 64 kbps. Although PCM is a preferred encoding format, other encoding formats are available according to the present invention. Likewise, other transfer speeds other that 64 kbps are also contemplated by the present invention. Generally, the digitized voice data transferred over transit network 16 can be in any format which is compatible and supported by both the originating network 14 and the terminating network 18.

Referring now to Figure 2, there is shown a block diagram of mobile station 12 according to a first preferred embodiment of the present invention. The mobile station 12 is provided with integrated voice recognition capabilities to verify authorized users of the mobile station 12 prior to a call being initiated between mobile station 12 and the serving originating network 14.

Mobile station 12 is seen to be comprised of a microphone 50 for receiving voice signals of the mobile user, this microphone 50 being connected to and providing the voice signals on line 52 to a transceiver 54. Transceiver 54 can be any of several conventional transceivers, and modulates the voice signal provided on line 52 to provide an RF carrier to antenna 55. In the case of a digital mobile station 12, the transceiver 54 or

other components may first digitize the analog voice signals provided on line 52 through analog sampling, and then may further encode the digitized voice using a vocoder or codec according to an encoding algorithm depending on the communication standard that mobile station 12 is based on i.e. GSM, TDMA, and CDMA.

Still referring to Figure 2, mobile station 12 can be seen to further include an improved Subscriber Interface Module (SIM) card 56 according to the preferred embodiment of the present invention. SIM card 56 includes typical standard features of conventional SIM cards including memory storing particular subscriber information including the mobile station serial number and a code indicative of the manufacture of the mobile phone. According to the present invention, the microphone 50 is connected to the SIM card 56 and provides a copy of the user's voice received by microphone 50 to the SIM card 56. SIM card 56 is further comprised of RAM memory, logic and digital sampling components capable of sampling the voice of users to be authorized to use the mobile station 12. The sampled voice forms a voiceprint, these voiceprints being stored in the RAM memory of the SIM card providing an index of voiceprints of authorized users for the particular mobile station 12.

Alternatively, the memory can be provided in circuitry elsewhere in the mobile station 12, and does not necessarily need to reside on the SIM card 56 itself, although this is the preferred embodiment. The entry of the voiceprints of authorized users can be entered into the RAM memory of SIM card 56 through a menu driven display on the mobile station 12 and may require a PIN number for entry. The voiceprints can comprise, for instance, the user stating his/her name or a particular password easily remembered by the authorized user. The size of the RAM memory for storing authorized users is adequate for storing an adequate number of authorized users intended to be authorized.

Mobile station 12 is further seen to comprise a voice recognition module 60 functionally connected and responsive to both microphone 50 and SIM card 56. Voice recognition module 60 compares the received samples of a user's voice from microphone 50 with the voiceprints stored on SIM card 56 to determine a match. If a match between the voice spoken through the microphone 50 is matched with one of the voiceprints stored on SIM card 56, then the mobile user is allowed to use the mobile station 12 to place a call, i.e. the handset 12 becomes active. Mobile station 12 is further provided with a fraud detection module 62 responsive to the

voice recognition module 60. If no match is found between samples of the voice spoken by the user via microphone 50 with one of the voiceprints stored in SIM card 56, as determined by voice recognition module 60, a signal is generated by voice recognition module 60 indicative of this mismatch on line 64, and fraud prevention module 62 responds to this signal to disable handset 12, such as by disabling transceiver 54 via line 68. Transceiver 54 remains in the disabled mode until voice recognition module 60 is able to detect a match between samples of the voice of the user provide via microphone 50 with one of the voiceprints stored in SIM card 56. Upon finally detecting a match, voice recognition module 60 will send a signal via line 64 to fraud prevention module 62. Fraud prevention module 62 will responsively send a signal via line 68 to enable transceiver 54 for transmission of voice via an RF carrier to the serving originating network 14. Alternatively, the handset 12 can be reactivated by entering an authorized PIN number. This feature is advantageous when an authorized user has a modified voice i.e. has a cold. This PIN number needs to be re-entered on a call-by-call basis. As a note, 911 calls do not require voice authorization to proceed.

Voice recognition module 60 preferably comprises a digital signal

processor (DSP) with embedded software for analyzing and comparing voice of the user, provided by microphone 50, with the digital voiceprints stored in the memory of SIM card 56. The present invention achieves technical advantages by embedding this voice recognition capability into the wireless mobile subscriber 12 to provide a voice recognition authorization feature ensuring that only authorized users of the mobile station 12 can initiate a call to the serving network 14. The voiceprints stored in SIM card 56 each have a predetermined data size.

The voice recognition module 60 is programmed with predetermined threshold which determines the extent that the voice sample given by the user has to match one of the voiceprints stored in SIM card 56. For instance, a 75% match may be determined a sufficient match. A match that falls below 75% triggers fraud prevention module 62 to inhibit the operation of transceiver 54.

Referring now to Figure 3, there is shown a second preferred embodiment of the present invention similar to the embodiment of Figure 2, wherein like numerals refer to like elements. In this embodiment, a mobile station 70 is provided with a speech monitoring module 72 being responsively connected to microphone 50 and SIM card 56. In this

embodiment, speech monitoring module 72 compares samples of a user's voice provided via microphone 50 during a call to the voiceprints stored in SIM card 56 to determine a match and establish the current user as an authorized or an unauthorized user of the particular mobile station 70. During a call, speech monitoring module 72 continuously samples the user's voice until a match to one of the voiceprints stored in SIM card 56 is detected. If by the termination of the call a match is not found between samples of the users voice and the voiceprints stored in SIM card 56, an output signal is provided on output line 74 to fraud prevention module 62 indicative of a mismatch, and fraud prevention module 62 responsively inhibits the operation of the mobile station 70, such as by disabling transceiver 54 via line 68. The transceiver 54 remains inhibited from further use until a voice sample is provided via microphone 50 and is determined by speech monitoring module 72 to match one of the voiceprints stored in SIM card 56. Speech monitoring module 72 also has a DSP digitizing the analog voice signals of the user and comparing the digitized samples to the digital voiceprints stored in SIM card 56. Similar to the first embodiment, an authorized PIN number can be entered into the handset to reactivate the handset. Moreover, 911 calls are not

prevented by the voice authentication process.

Referring now to Figure 4, there is shown a block diagram of a third embodiment of the present invention providing an intelligent network (IN) solution providing voice recognition of a mobile subscriber using mobile station 12. Communication network 10 is seen to include an external IN node 80 functionally coupled to the originating network 14, shown as being functionally coupled to MSC 34. However, the location of the IN node 80 with respect to the devices of originating network 14 can vary from system to system as desired, and for instance, can be connected to the BSC 32 if desired. IN node 80 provides an IN solution including functional modules providing voice recognition of mobile users.

Referring to Figure 5, these functional modules include a voiceprint recording module 82 which records voiceprints and/or voice samples of all valid mobile station users for each of several mobile stations 12 served by the network 10. A voice monitoring module 84 compares the voice samples from a current mobile station user using, or attempting to use, mobile station 12 with those voiceprints stored in the voiceprint recording module 82. A fraud prevention module 86 is an application which handles identified fraudulent use of the mobile station 12. If voice

monitoring module 84 does not establish a match between voice samples of the current mobile station user with one of the voiceprints stored in the voiceprint recording module 82 associated with the particular mobile station 12, the fraud prevention module 86 responsively provides a network message back through the originating network 14 to mobile station 12 to disable the mobile station 12 from further use until an authorized voiceprint is provided from mobile station 12 to the IN node 80.

Referring now to Figure 6, there is shown a method of the present invention at 90. At step 92, voice samples or voiceprints of authorized users are stored into a voiceprint storage location, such as SIM card 56 located at the mobile station, or into the voiceprint recording module 82 of IN node 80 as shown in Figure 5.

At step 94, the voice sample of a current user is compared to the recorded voiceprints to perform authentication of the current mobile station user. This is done by voice recognition module 60, speech monitoring module 72, or voice monitoring module 84.

At step 96, it is determined whether the current user is an authorized user by analyzing the results of the comparison of step 94.

This determination is performed by the voice recognition module 60 in Figure 2 prior to a call being placed, by the speech monitoring module 72 in Figure 3 when a call is underway, and by the voice monitoring module 84 in Figure 5 using the IN solution.

Next, at step 98, a call is processed depending on whether or not a current user has been authorized. The step takes the form of either preventing future calls until an authorized user is identified for the embodiment of Figure 2, allowing the current call to continue but preventing further calls at the conclusion of the current call in the embodiment of Figure 3, and for the IN solution shown in Figure 5 all calls can be prevented until an authorized user has been determined, or the current call can be continue while preventing future calls, depending on the algorithm chosen to be programmed into IN node 80.

Though the invention has been described with respect to a specific preferred embodiment, many variations and modifications will become apparent to those skilled in the art upon reading the present application. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the prior art to include all such variations and modifications.

WE CLAIM

1. A mobile wireless communications device for use in a wireless communications network, comprising:

an input device for receiving voice signals of a current user;

storage means for receiving and storing a voice sample of at least one authorized user;

a speech comparison module comparing received voice signals of the current user with said stored voice samples and generating an output signal indicative of if the current user is one of said authorized users; and

means enabling and disabling said device as a function of said output signal.

2. The device specified in Claim 1 wherein said storage means comprises a SIM card.

3. The device specified in Claim 2 wherein said input device comprises a microphone.

4. The device specified in Claim 1 wherein said mobile wireless communications device comprises a wireless telephone.

5. The device specified in Claim 1 wherein said received voice signals are compared with said stored voice samples prior to said device communicating said voice signals to the wireless communications network.

6. The device specified in Claim 5 wherein said device is disabled prior to transmitting said voice signals to the communications network if the current user is not identified as one of said authorized users.

7. The device specified in Claim 1 wherein said received voice signals are compared with said stored voice samples while said device is communicating said voice signals to the wireless communications network.

8. The device specified in Claim 1 wherein said device is disabled after said device completes communicating said voice signals during a call to the wireless communications network.

9. The device specified in Claim 1 wherein said device further comprises a display, wherein said display displays a visual message as a function of said output signal indicative of if said current user is recognized as one of said authorized users.

10. A wireless communications network, comprising:

network means for establishing a wireless telephony call between a wireless originating communications terminal and a terminating station; and

fraud prevention means having a voice recognition means for selectively authorizing use of said wireless originating communications terminal with said network means as a function of voice samples provided by a user attempting to use said wireless originating communications terminal.

11. The device specified in Claim 10 wherein said fraud prevention means comprises an IN node functionally coupled to said network.

12. A method of authenticating a mobile user attempting to use a wireless mobile station in a wireless communications network, comprising the steps of;

storing a voice sample of at least one authorized mobile user in a first storage means;

obtaining voice samples of a current mobile user;

comparing said voice samples of the current mobile user with said stored voice samples of authorized mobile users; and

setting the operability of said wireless mobile station as a function of compared voice samples.

13. The method as specified in Claim 12 wherein said mobile station is disabled when the current user is not identified as one of said authorized users.

14. The method as specified in Claim 12 wherein said voice samples of the current user are obtained prior to establishing a call between said wireless mobile station and said wireless communications network.

15. The method as specified in Claim 12 wherein said voice samples of the current user are obtained while a call is established between said wireless mobile station and said wireless communications network.

16. The method as specified in Claim 14 wherein mobile station is prevented from use until the voice sample of the current mobile user is recognized as one of said stored voice samples of authorized mobile users.

17. The method as specified in Claim 15 wherein said mobile station is prevented from further use after said established call is terminated until the voice sample of the current mobile user is recognized as one of said stored voice samples of authorized mobile users.

18. The method as specified in Claim 12 wherein said voice samples of said authorized mobile users are stored in a SIM card of said wireless

mobile station.

19. The method as specified in Claim 12 wherein said voice samples of said authorized mobile users are stored at a node of the wireless communications network.

20. The method as specified in Claim 12 further comprising the step of displaying a message at said wireless mobile station indicating said wireless mobile station is disabled if said compared voice samples of the current mobile user and one of said voice samples of said authorized users do not match.

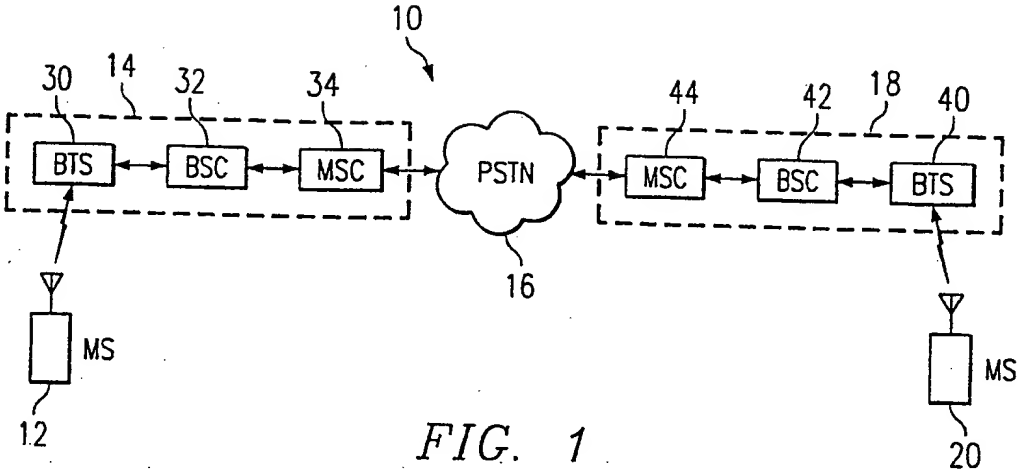

FIG. 1

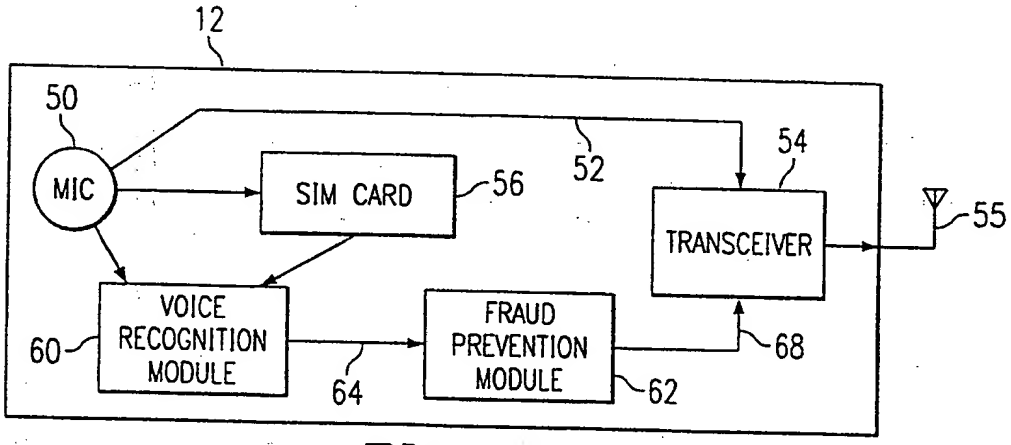

FIG. 2

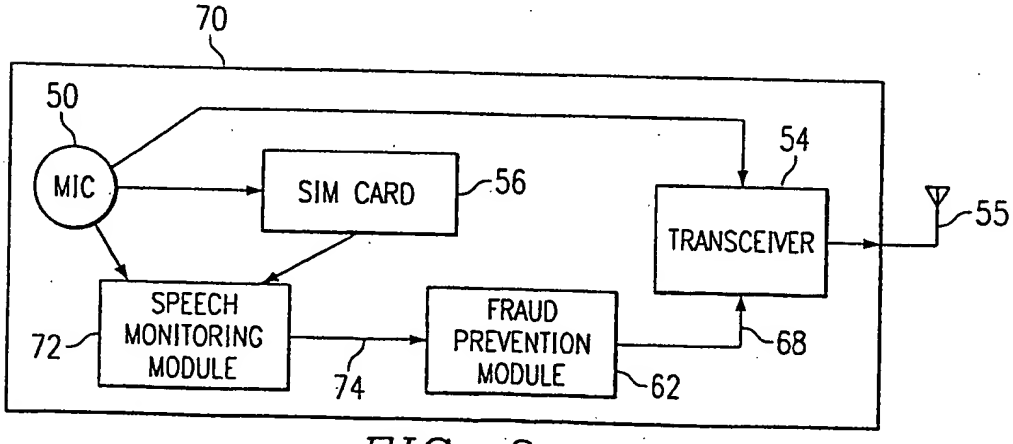

FIG. 3

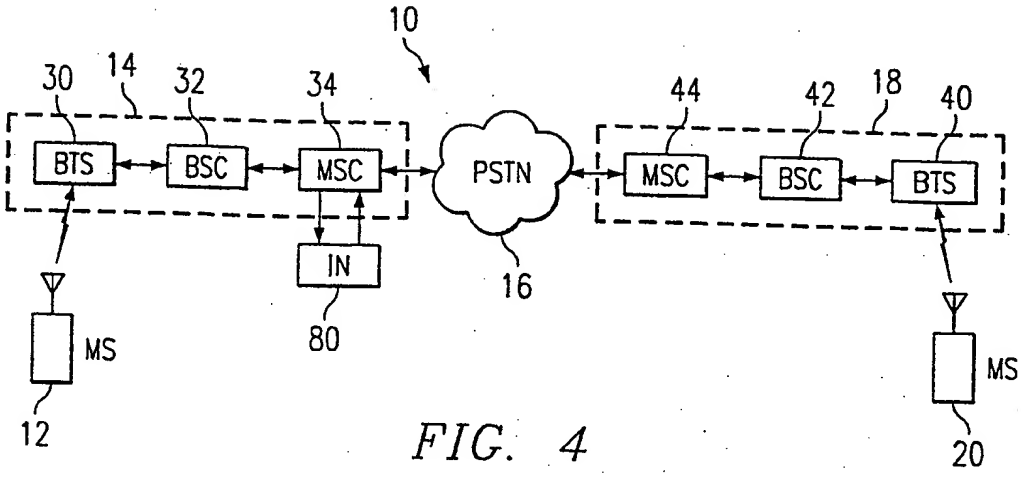

FIG. 4

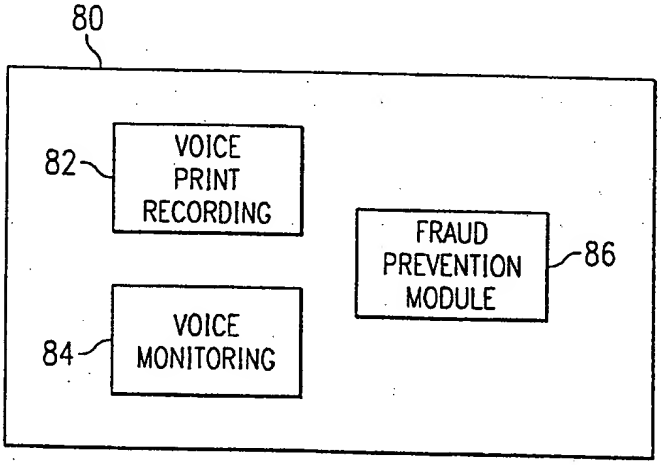

FIG. 5

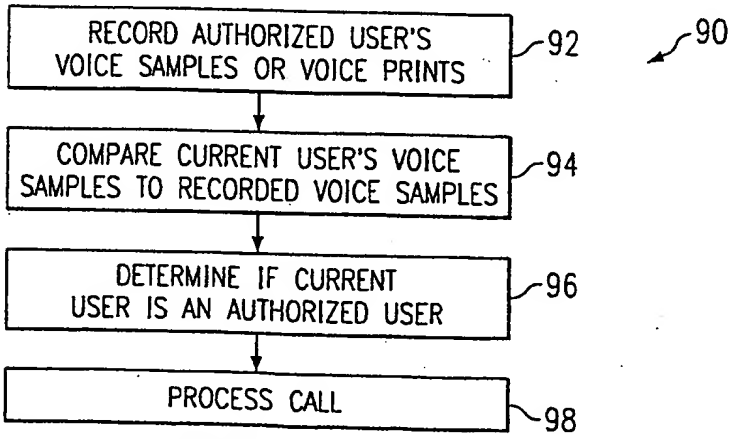

FIG. 6

INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/US 99/22203

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04M1/66 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04M H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LAPERE ET AL: "User Authentication in Mobile Telecommunication Environments Using Voice Biometrics and Smartcards" FOURTH INTERNATIONAL CONFERENCE ON INTELLIGENCE IN SERVICES AND NETWORKS, IS&N '97. PROCEEDINGS, 27 - 29 May 1997, pages 437-443, XP002106691 Cernobbio, Italy paragraphs '0004!,'0006!	1-7, 10-19
X	US 5 805 674 A (ANDERSON JR VICTOR C) 8 September 1998 (1998-09-08) abstract; figures 1,2	1,3,4,7, 8,10-12, 15-17,19

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☒ Patent family members are listed in annex.

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1 February 2000	09/02/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Interi. ..nal Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5805674 A	08-09-1998	NONE	